

REPORT

OF THE

BOARD OF COMMISSIONERS

OF

ELECTRICAL SUBWAYS,

OF THE

CITY OF BROOKLYN.

DATED OCTOBER 31, 1896.

BROOKLYN :

1896.

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REPORT.

BROOKLYN, October 31st, 1896.

HON. FREDERICK W. WURSTER,
Mayor of Brooklyn.

DEAR SIR :

The Board of Commissioners of Electrical Subways respectfully offers the following report of work performed within its jurisdiction since December 15th, 1895, the date of the last Annual Report. The presentation of this paper at this time is due to the fact that the work of the board must terminate with the present month. The statute creating the board contains the following clause: "The term of office of such commissioners shall expire on the first day of November, eighteen hundred and ninety-six, and from and after said time the powers and duties of said commissioners shall in each of such cities devolve upon and be vested in the mayor of such city, and the commissioner of city works, or in place of the commissioner of city works, in such other local officer having the charge of the streets and highways of such city."

The following is a brief summary of the extent of the various electrical system in the City of Brooklyn, the estimate being made to apply to the condition existing on the 1st of October. The amounts would require some modification to fit the date of November 1st, as the work of extension is being vigorously prosecuted.

Aggregate length of electric conductors of all kinds within city limits is 22,052 miles.

Increase during this year, 1,681 miles

Total length of wires underground or suspended from elevated railways is, 14,248 miles.

Increase since January 1st, 1,939 miles.

Total length of underground conduit is, 136 miles.

Length of single duct, 377 miles..

Sixty-five per cent. of the electrical conductors within city limits are under the streets or suspended from the trusses of the elevated roads, or, excluding the city's wires from the estimate; sixty-nine per cent. of all wires under the jurisdiction of this board are thus disposed of.

The growth of the several systems during the present year is given in detail immediately following the subjoined table which exhibits the mileage of wire belonging to the several companies at the beginning of the present year.

	MILEAGE		
	Aerial.	Underground.	
New York & New Jersey Telephone Company	39 ⁶ ₅ 7 ³ ₂ 45	(a) 11,665.51	13 58 8.4
Municipal Electric Light Company	25 ⁹ ₇ ...	224.50 (b)	82.00 87.2
Edison Electric Illuminating Company	.....	280.00	292.6
Citizen Electric Illuminating Company	42 ⁸ ₃ 3 ¹ ₂ 380.00		15.00
Flatbush Gas Company	.....	82.20	
Gold & Stock Telegraph Company	.....	12.30	
American District Telegraph Company	.....	150.00	
Stock Quotation Telegraph Company	.....	26.50	23.17
Postal Telegraph Company	.....	31.50	
Fire Department	.....	791.62	
Police Department	.....	445.00	7.00
Brooklyn District Telegraph Company	.....	147.00	
Holmes' Electric Protective Company	.....	11.00	
Eastern District Messenger Company	.....	12.00	
Union District Messenger Company	.....	0.00	
New York & Eastern Telegraph & Telephone Company	..... (c)		
Western Union Telegraph Company	.....	338.00	69.11
National Automatic Fire Alarm Company	.....	24.00	
Brooklyn Heights Railroad Company Lessees (Trolley)	.....	408.31	130.00

		MILEAGE.
		Aerial. Underground.
Kings County Electric Railway Co. (Trolley) . . .		
Coney Island, Fort Hamilton and Brooklyn	221.55	
Railway Co. (Trolley)		
Nassau Electric Railroad Co. (Trolley)		
Brooklyn City & Newton R. R. Co (Trolley) . .	39.60	15.97
Atlantic Ave. Railroad Company (Trolley) . . .	113.67	
Coney Island and Brooklyn Railroad Company	39.25	13.50
Brooklyn, Queens County and Suburban Rail-		
road Company (Trolley)	45.20	1.90

- (a) Including 4,401.32 miles suspended from the elevated railways.
 (b) Including 77.75 miles suspended from the elevated railways.
 (c) No mileage reported.

The underground work during the year has been conducted with reference to relieving those streets of pole lines which were about to be newly paved or were completely lined with dwellings.

In sections remote from the completed subways, pole lines have been extended as heretofore, the extensions being regulated by the requirements of public interest, though sometimes subjected to restrictions owing to local opposition.

THE ELECTRIC LIGHTING SYSTEMS.

The Edison Company under its old franchise has extended its system of wires by a length of 12 6-10 miles enclosed in 4 2-10 miles of tubing. Lately many cases of electrolytic corrosion have been discovered amounting to utter destruction of considerable lengths of their underground tube.

Under the franchise of the Citizens' Electric Illuminating Co., the above corporation has extended its aerial system into new districts. The subways for this system which were constructed last year have been in use this year but with indifferent success. Cables constructed for the purpose of carrying the high tension current demanded by the system failed repeatedly and rendered necessary a return to the aerial line in order to fulfill the contracts for lighting. This series of accidents has prevented the removal of the heavy pole line in Rockwell Place. The defects in the subway line have been cured, and the clearing of the above locality of its old overhead system is begun.

Some proposed extensions of the pole line in Fifth avenue for the purpose of lighting the avenue were met by opposition of the citizens. The company abandoned the plan and the gas lights were retained.

The length of overhead wires belonging to this company has been increased by 122.25 miles, mostly in the suburbs. The amount removed from the thickly settled portions of the city is 53.93 miles.

The clearing of the region above referred to in the vicinity of the power station, which will be effected before the close of the year, will result in the further reduction of overhead lines to the extent of 37.19 miles of wire and about 100 poles.

The Municipal Electric Light Co. has increased its aerial system by 34 1-2 miles, and its underground by 4 6-10 miles. This company now has 259 miles of wire on poles; 87 3-10 miles in conduits or suspended from the elevated railroad.

THE NEW YORK & NEW JERSEY TELEPHONE CO.

The extension of the telephone system has been greater than that of any previous year. Not much change even in the details of construction has been required within the last two or three years. The wires buried in the early days of subway work have mostly required removal; the change to a metallic circuit from the original grounded one, the destruction of the lead covering of the cables through two or three causes, chiefly electrolysis, have rendered an extensive amount of reconstruction necessary.

The Long Distance Telephone is connected with the system of the New York and New Jersey Telephone. The former system suffers by being associated with other wires in underground cables even for short distances.

Telephoning to distant cities from Brooklyn is beset with much difficulty, whereas from New York the service is satisfactory to points within the distance of 1000 miles; the difference is attributed to the fact that the special wire of the "Long Distance" is buried between Brooklyn and New York. From the New York office it is extended on poles.

The Telephone Company has increased its mileage of conductors in subways by 1922.9 miles, and diminished its aerial line by 525.12 miles, since January last.

THE DISTRICT TELEGRAPHS.

No change of policy has been adopted towards these systems. The remarks of the previous report may be repeated here:

“The District Telegraph Companies employ only aerial lines which are mostly supported on house-tops. To insist on the burial of these wires would abolish the system. The expense of underground conductors would render its operation, at present rates, or at any prices commensurate with services afforded, impracticable. Clearly, then, the public interests do not require the burial of these wires. The burglar alarms and the messenger boys cannot be dispensed with, and while citizens demand this simple and serviceable means of electrical communication, the wires must remain in the air. Possibly with a more general use of the telephone, which is certain to come, the two distinct services may be performed by one system of underground conductors.”

The Automatic Fire Alarm Company has added 15 miles of wire to its system during the year.

THE POLICE AND FIRE DEPARTMENT SYSTEMS.

The extension of the city wires has kept pace with the additions to the city's area. The Fire Department System has been increased 80.47 miles since January.

These wires supported on poles are to remain in this condition until an appropriation is made for the specific purpose of constructing an underground system.

The estimated expense of such a change is about five hundred thousand dollars.

THE CORROSION QUESTION.

The subject of corrosion of underground pipes and cables still demands serious consideration. The survey made in 1894, of the electrical condition of the districts traversed by the trolley lines was not continued in 1895, for the reason that the Nassau Trolley System was in process of construction, and the whole problem of underground currents was assuming larger proportions and presenting new complexities.

As the new lines were practically completed early in the present year, a new survey was made during the summer under the direction

of Mr. John A. Barrett, whose report is submitted as a part of this communication. The appended map plainly exhibits the danger areas within which service pipes are probably suffering deterioration.

This survey included numerous examinations of the water pipes which could only be made by excavations in the streets. In this work this Board received the efficient and hearty co-operation of the Department of City Works. Excavations were made wherever it was deemed desirable to make a direct examination of the water main.

One gratifying conclusion was arrived at as a result of this thorough examination, and that was that in the districts where underground pipes are most liable to destruction by electrolysis, the cast iron water mains remain intact. Wrought iron and lead pipes deteriorate steadily and rapidly, in places where cast iron shows no sign of decay.

The statement in a former communication from this Board that the water system of the city was seriously endangered and probably already impaired by electrolytic corrosion, now requires modification to the extent that such injury is confined to such branches as are constructed of wrought iron or lead.

The immunity from injury by the ordinary process of oxidation, possessed by cast iron, was long since pointed out by engineers, one of whom declared that it was his belief that the so-called white casting is practically indestructible under the action of ordinary oxydizing influences. *

* Abstract of a paper read before the American Society of Civil Engineers in 1871 on "The Corrosion of Iron," by Hon. Wm. J. McAlpine.

* "This subject was very thoroughly discussed by some of the most eminent engineers of the London Society in 1862, and numerous cases were cited both of corrosion and its absence in iron under water, and the causes explained.

"The examples then stated, and numerous others, showed that cast-iron of a particular description corroded rapidly, or changed its structure, by a few years immersion in foul and salt water, while other irons were entirely unaffected when exposed in the same way for 20, 30 and 40 years.

"In the same structure, as in the case of the iron gates of the Sheerness Dock, three pairs of gates had resisted the action of salt water for 40 years, and a portion of the fourth pair, put in several years later, had been much softened and injured by its exposure.

"Several of the leading engineers instance numerous cases of square cast-iron piles standing in and partly out of salt water, and a portion alternately wet and dry at each tide, which, after periods of 18, 24, and 31 years, and intermediate periods, showed no

It would seem likely, therefore, in view of the perfect preservation of the water mains under conditions that lead to the destruction of wrought iron and lead pipes, that whether through design or not the large pipes have been made of a quality of iron that insures their safety.

The inconvenience and loss resulting from the electrolytic corrosion is not limited to the destruction of the pipe or cable covering. From the corrosion of gas pipes there results a leakage of gas which destroys trees, threatens the health of the neighborhood and increases the danger of explosions in manholes and cellars.

The corrosion of water pipes leads to waste of the city's water supply, while the destruction of the buried electric cables tends to seriously limit the area within which electric conductors can be successfully operated in subways. Moreover the destruction of either kind of so-called service pipe, whether delivering water or gas calls for frequent disturbance of the street pavements.

In some places service pipes extending beneath the trolley tracks have been repeatedly destroyed and removed, each removal, of course, requiring an excavation, a refilling and a relaying of the pavement.

It should be here stated, however, that destruction of the underground pipes is not limited to the streets occupied by the trolley lines. The map plainly shows danger areas at some distance from the street railway lines.

The trolley companies have during the year done much to keep the destructive current on the path of their own conductors, so that the injury is doubtless less rapid than it was two years ago, but a

signs whatever of corrosion or change—the square angles of the iron were as sharp as when they left the foundry.

"Mr. Simpson, the past president, said that in his practice he used great care in the selection of the iron, and such iron was practically incorrosive.

"The members stated that wherever this corrosion or decomposition had occurred, it was wholly due to the quality of the iron. The engineer has, therefore, only to select that of a proper quality to insure durability.

"My own experience and examinations so far as they reach confirm these opinions.

"Cast-iron, to resist corrosion to its greatest extent, should be as hard as the case will admit, of an even, close grain, and with the carbon combined and not in the form of graphite. Impure, soft foundry iron will corrode rapidly: close-grained gray iron, of an even texture, will resist corrosion in the most exposed places without sensible injury, and white iron of good quality may, for all practical purposes, be considered as imperishable in such situations."

means of absolute prevention of the injury so long as the pipes are of a kind liable to corrode, is not yet made known.

The escape to the earth of a portion of the current discharged into the rail is a condition inseparable from the single trolley system.

Non-metallic service pipes for conveyance, both of gas and water, are plainly desirable in the present emergency.

One citizen who has suffered the loss of service pipes, three times, is about to adopt a remedy, which although admissible in his case, (in a narrow street near the water front), is plainly impracticable in other localities. The pipe is to be carried across the street (which is occupied by three trolley lines) on elevated supports.

The report of Mr. Barrett herewith appended, plainly and specifically sets forth the situation, and will be found a valuable contribution to the literature of a subject which has lately risen into prominence, and is regarded with lively interest in many American cities.

In order to inform the citizens of the conditions existing in our city, this Board proposes to prepare for the press such a modification of the map accompanying this report as will indicate at a glance the sections where the repeated decay of the service pipes may fairly be attributed to the escaping electric current from the trolley systems.

The total length of electrical conductors within the city limits when this board began its work in June, 1892, was in round numbers 9,800 miles, of which about 6,000 was on poles or house tops. Comparing these figures with the totals given above, it is shown that the increase in the length of wires during the existence of the board has been about 12,200 miles, of which amount, somewhat over 10,200 miles have been provided for in conduits or on the elevated railways.

One hundred and eighty miles of conduit containing 280 miles of single duct have been constructed in the same period.

Respectfully submitted,

GEO. W. PLYMPTON,

FRED R. LEE,

Commissioners.

APPENDIX.

REPORT TO THE BOARD UPON THE ELECTRICAL SURVEY BY MR. JOHN A. BARRETT.

To the Board of Commissioners of Electrical Subways of the City of Brooklyn.

GENTLEMEN :

In carrying out the purposes of the board, I have had a survey made of the electrical state of the Brooklyn City water mains, and a map prepared upon substantially the same plan as that followed in the survey of 1894.

The conditions of things broadly stated, is that heavy quantities of electricity are being sent out by the trolley lines from power houses diversely located in the city, and from the overhead wires are being discharged through the moving cars into the track rails.

After passing through the car-motors to the rails the electricity returns by all available paths to the several power houses. It was originally designed and expected that the rails would be able to carry back practically all of the returning current, but the path afforded by the rails is not ample for the purpose, and the rails being in intimate contact with the earth which is itself a conductor of electricity : a considerable amount of electricity is crowded off the rails into the earth in certain parts of the city ; and from the earth is largely gathered up by the neighboring water and gas pipes, and is generally by these pipes carried back into the vicinity of the power houses, and is there discharged into the earth again.

As a rule the main underground pipes are receiving electricity in those sections of the city which are remote from power houses and are parting with it into the earth again in districts near to power houses ; though this rule is subject to exceptional instances. And finally the liability to corroding electrolysis is confined to those conditions under which there is a tendency of electricity from the pipe into the earth.

This brief recapitulation of what is recognized as fundamental in the electrolysis of underground pipes by trolley currents, is all that is necessary to enable us to proceed with a discussion of the subject in the light of recent observations.

Referring to the map, the small figures printed in black indicate the tendency, as measured at the hydrants above the surface, of the trolley currents to flow towards and into the water mains. This tendency is not regarded as locally hurtful to the pipes ; but all the electricity, which is thus imposed upon a pipe passes along the pipe to some other locality more or less distant, where

the conditions favor its leaving the pipe for the earth towards its destination at the power house.

Where the measurements at the hydrants indicate a tendency of electricity from the pipes into the earth, the figures are printed in red, and the pipes in districts so marked are generally considered as liable to electrolieritic corrosion.

This overflow of electricity from the rails into the earth and the consequent damages to the pipes by electrolysis are a radical fault of the single trolley system of traction, due as stated above to the contact of the rails with the earth and the insufficient conductivity of the rails for the heavy flow of returning electricity. Having this clearly in mind, it is evident that a logical treatment of the subject would require first that the conductivity of the rails as a return path should be reinforced in the most effectual possible manner and to the highest practicable degree considering only cost and the special condition of the territory. This was pointed out as a first requisite in my report of 1894. Since then the return paths have been materially improved in some parts of the city, both by a better bonding of the rails together, and by attaching to the rails at intervals overhead return feeders, by means of which much of the current is drawn off from the rails and conveyed back to the power houses by special conductors.

If a suitable and complete system of return feeders were worked out and applied to the entire surface track of the city, it would be reasonable to expect the reduction of a large proportion of the damage now being committed upon the pipes and it would leave fair hopes of treating by other means the residue of the trouble so as to bring it within bounds.

But after every advisable effort has been made in this radical method of reducing the overflow of current: namely, by improvements in the bonds and return feeders, there will yet inevitably remain considerable, though diminished earth currents, which will subject the pipes to electrolysis under favorable conditions; and the question will still arise as to other serviceable means for meeting and removing these remaining instances of damage.

A large share of the comparatively limited time allotted to the survey was devoted to looking for and examining instances where electrolysis was known to exist, or was to be expected from surface indications, with a view to useful suggestions upon this head.

First in behalf of the city, excavations were made in not less than fifteen places upon the water mains, where the tests upon the hydrants showed what was regarded as a decisive liability to damage.

The mains at these excavations were in nearly every instance inspected, both by Mr. H. S. Wynkoop, Inspector of Gas and Water for the Department of Public Works, and by myself, and in several cases by Prof. Plympton of your board, and always by experienced pipemen of the Water Department, and in no instance did we find evidences of corrosion distinctly attributable to electrolytic action. This is so interesting and remarkable an observation that it is worth while to state in detail the noted conditions of some of the cases.

On July 29th an excavation was made at a hydrant under the East River Bridge upon a branch running down towards the river from the main on

Water street. There is a general drop in potential from the main towards the river in this vicinity, and a discharge of electricity into the earth from branches and service pipes extending from the main in that direction.

The effect of this has been manifested in the destruction of service pipes, both of lead and wrought iron. The electrical test upon the hydrant in question showed a fall in potential varying from 1.4 volts to 2.2 volts into the water of the river, and it was fully expected that we should find unmistakable electrolytic action.

The branch leading to this hydrant is of cast iron, and is bedded in a mixture of what appears to be sand and cinder, and is below the high tide level. The pipe is said to have lain here for about seventeen (17) years, for more than two of which it has been discharging trolley electricity into the earth. The pipe showed some deterioration on its surface and in some places patches of crusted scale. There was no deep corrosion, and from the fact of the long exposure of the pipe to the action of cinder and salt water at a level between high and low tides, the present fair state of the pipe precludes its being taken, to say the least, as an example of electrolysis.

On July 30th an excavation was made in Plymouth street, between Main street and Dock street, where the fall in potential from hydrant to river was 2.7 volts and also at the foot of Adams street, where the fall of potential was about 1 volt, and on August 5th on the Fire Dock at the foot of Main street, where the fall of potential was 1.3 volts.

The same observations were made in all these cases. Where the pipes, being of cast iron, lay in cinder within reach of the tide water, there was present a considerable amount of hard, red scale; otherwise, the pipes appeared generally free from corrosion. The pipes were not in any case deeply corroded.

Perhaps the most notable instance examined was at the foot of First street, between Bond street and the Canal. The fall in potential from the hydrant at the end of a branch, was on the average 4 volts into the water of the canal at a distance of about 46 ft. There was a considerable fall of potential from point to point in the earth between the hydrant and the canal. Upon having the pipe uncovered, I found that the fall in potential from the pipe to a point in the earth, less than an inch removed from the pipe was .36 volts. The cast iron pipe showed no evidence of electrolysis.

But what is to be specially noted in this case, is that some wrought iron clamps and bolts, employed to fasten a cap upon the end of the pipe, were seriously injured by corrosion.

In all the cast iron pipe examined by us, the same observations were made.

Associated with this apparent preservation of the cast iron mains under conditions generally supposed to favor electrolysis, is the observed fact that wrought iron and lead service pipes and wrought iron clamps and bolts immediately attached to the uninjured cast iron and exposed to the same conditions, show unmistakably the expected electrolytic corrosion. It is to be regretted that our observations upon this matter were necessarily so limited, since an exact and reliable determination of it is of immeasurable interest,

both to the city and the railroad companies, as well as to all people who are concerned with buried pipes. From such an examination as we were able to make, it would be unwarrantable to assert broadly that cast iron of any particular quality, possess an absolute immunity from electrolysis. In fact, a test applied to a fragment of cast iron pipe in a tin pail of earth, with a drop of potential of 10 volts from the fragment to the pail, gave in three weeks undoubted evidences of electrolysis of the iron. But from a careful investigation of the facts so far as we are able to proceed with it, I think it is at least safe to suggest that at low potentials, cast iron, of such quality as exists in the water mains which were examined, will endure practically unharmed a flow of current into the earth, which under the same conditions is totally destructive to wrought iron and lead.

It is not to be taken, from what has thus been said, that no damage is being done to the city's water mains by the trolley currents. The statement simply is that a number of excavations were made upon the mains in places where, according to all the published propositions which have come to my attention on the subject, a strong presumption of damage existed, and no damage was found; while under the same conditions wrought iron and lead contiguous to the cast iron were being destroyed.

If it could be determined by sufficiently extensive investigations that some specified fraction of a volt in drop of potential from pipe to earth could safely be allowed in the case of cast iron, it would, in my opinion, be entirely feasible for the railroad companies to reduce the present potentials upon the pipe to a fair standard in nearly every situation in the city, by a proper extension and adaptation of their return feeder system.

Wherever potentials greater than the prescribed standard were still found to exist there would then be the opportunity to treat the cases specifically by means of negative conductors attached to the mains as was done in 1894 along Third avenue, or by bonding the mains to the rails or by any other similar means which might be serviceable.

In this connection it has been objected that any plan which permitted the attachment of conductors from the pipes to the return systems of the railroads would, by promoting an increased flow of current along the pipes, cause a very serious corrosion at the joints in the pipes throughout an indefinite extent of the city. On this account no permits have been granted for making such attachments except in the case of lower Third avenue in 1894.

Examples of electrolysis of wrought iron pipe at joints are of common occurrence; but in all the cases of cast iron mains which have come under my observation in Brooklyn, no such corrosion at or by any reason of joints has been discovered. The most notable instance of absence of this particular kind of trouble upon the mains was found in Third avenue between First and Third streets. This location was selected for excavation because the condition indicated an excessively heavy flow of current along the main, probably heavier than in any other place in the city. The flow here has continued for two years to our certain knowledge, and no doubt, longer. It is far above what should be permitted to exist and may readily be reduced. I was unable to get a measurement of the flow, but some indirect calculations indicated that it

amounted to several thousand amperes. The drop in potential around joints in the main was found to be from one to two volts, and at our request four lengths of pipe including three joints intact were removed. In company with Mr. Wynkoop and experienced pipe men of the Water Department, I inspected this pipe with the closest attention, and it was agreed that there were no evidences of electrolysis or any other corrosion to be found.

Again it is to be regretted that the number of observations upon this point was necessarily so limited, for while this case is an extreme one I do not know a situation in the city where a pipe of the same size is carrying so heavy a current, and it is supported by all our experiences in Brooklyn; still altogether these hardly constitute broad enough grounds upon which to base the absolute negative conclusion that there are no cases of electrolytic corrosion at the joints in the cast iron mains of the city.

The whole proposition with respect to the electrolysis of cast iron pipes must be left by us with the summary statement that, although we hunted for it to the extent of the time and means provided and in situations where, under the generally accepted principles of the subject we expected to find it, we did not find a single instance of corrosion of cast iron which we could attribute the action of electricity.

As a matter of general interest, although somewhat aside from the present subject, I will state of the main examined in Third avenue, that it was difficult from the condition and appearance of the pipe to suppose that it had been in the ground for any long period, and yet the records of the Water Department show that it was laid 28 years ago, and during the last two years and more it has been subject to the passage of trolley currents. It is said to have been manufactured by the Camden Iron Works.

Upon breaking up a sample of the pipe the iron was found to be exceedingly hard, and the appearance of the fracture is of a brilliant light gray, and of a fine even grain.

But granting that the city's water mains are not so seriously menaced by the trolley currents as has been supposed, all this does not help the situation with respect to wrought iron and lead surface pipes, or with respect to wrought iron gas pipes, or electric conduits, or lead cable sheaths, all of which are found to be attacked and rapidly destroyed under conditions by which the cast iron mains appear to be unaffected.

Whatever may further be done by the railroad companies to improve their rail-bonds and to increase their return feeders, will be of direct advantage to any case of electrolytic trouble upon other than water mains which now exists, because that is a radical treatment of the cause of the difficulty. Beyond this every instance of damage will have to be treated specifically and for the most part locally according to the special conditions. Only the most general and brief suggestions can at present be made in this direction.

There are situations in the city where a marked difference of potential exists between the gas pipes and water mains. Where such situations are located it is my opinion that it would be of mutual advantage to bond the two systems of pipes together by metallic conductors. We have noted cases where there is a difference of potential between gas and water service pipes in the

same house. This is not only an undesirable condition with regard to possible electrolysis, but it is entirely conceivable that under favoring circumstances it might prove to be the origin of fires for which no other cause is assignable. This would be entirely met by bonding together the gas and water service pipes just inside the cellar wall of the house.

There are undoubtedly localities in the city where service pipes are being destroyed by electrolysis, and are being renewed at great cost to the householders, only to be rapidly eaten out again, and where the trouble would be very much reduced if not altogether removed by a systematic and thorough bonding of the service pipes to the trolley rails; but care would need to be taken in applying such attachments to service pipes to avoid an increased joint corrosion to which the wrought iron pipes are liable; and no water pipe should be allowed to be bonded to the rails without including with it the gas pipe for the same house.

There are other situations where no method of bonding would be of material advantage. Such a condition exists along the river front generally from Erie Basin to and including a part of the Navy Yard. Service pipes in this region are discharging current from the mains towards the river.

In these cases unless the pipes could be removed from the ground and suspended in the air, which might be feasible in a limited number of instances, I see no relief for the continued destruction of service pipes where the electrical conditions promote it, except in the employment of some material for the pipes which would not be subject to electrolysis. What such a material should be I do not undertake to say, but it is presumable that amongst the fibrous compounds manufactured for various purposes, something might be found adaptable to this use. In fact, the general employment of non-metallic material as a substitute for iron or lead in exposed places, if something suitable could be procured, would radically and finally remove all the electrolytic troubles from the smaller pipes in the city, and with an appreciation of the extensiveness of the damage now affecting the metallic pipes in considerable districts, I bring this suggestion forward as well worth the attention and research of those interested in the matter.

With such rather broad and general remarks I am obliged to dismiss the subject for the present, but not without characterizing the report as on the whole indicating a state of affairs with regard to the electrolysis of the Brooklyn water mains not nearly so bad as was reasonably to be expected, and expressing a degree of hopefulness in respect to what may be done to protect and help the private owners upon whose pipes the indications are unfavorable, and the damage already done undeniably extensive.

I remain, very respectfully,

JOHN A. BARRETT,

Electrician.

18 Cortlandt street, New York.

LIST OF POWER HOUSES.

MAP	OPERATED BY	LOCATION
A	BROOKLYN CITY R.R.C.O.	52 nd ST AND 1 st AVE
B	-	KENT AND DIVISION AVES
C	-	WICHOFF AVE AND GATES AVE
D	BROOKLYN CITY AND NEWTON R.R.C.O.	DE KALB AVE AND CENTRAL
E	ATLANTIC AVENUE R.R.C.O.	3 rd AVE AND 1 st AND 2 nd STS
F	CONED ISLAND AND BAYON R.R.C.O.	SMITH ST AND 9 th AND 10 th STS
G	NASSAU ELECTRIC R.R.C.O.	39 th ST AND 1 st AVE

ROUTES	SUPPLIED BY CURRENT FROM
—	BROOKLYN CITY R.R.C.O.
—	ATLANTIC AVE R.R.C.O. AND NASSAU ELECTRIC R.R.C.O.
—	CONED ISLAND AND BAYON R.R.C.O.
—	BROOKLYN CITY AND NEWTON R.R.C.O.

DP BETWEEN Water System and Rails of Trolley Roads along Routes is shown thus

WATER SYSTEM AND CANAL IS SHOWN thus

WATER SYSTEM AND A GROUND PLATE IMMERSSED IN BAY OR HILL IS SHOWN thus

BLACK FIGURES INDICATE THAT WATER SYSTEM IS NEGATIVE

RED FIGURES INDICATE THAT WATER SYSTEM IS POSITIVE

J A M A I C A

B A Y

MAP

SHOWING THE TROLLEY-CAR LINES AND THE

ELECTRICAL CONDITION OF THE WATER MAINS

OF THE CITY OF

BROOKLYN.

PREPARED BY THE

BOARD OF COMMISSIONERS

ELECTRICAL SUBWAYS

BROOKLYN

SEPTEMBER 1894



